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Stock structure and seasonal movements of Atlantic cod (*Gadus morhua*) in NAFO Divs. 3KL inferred from recent tagging experiments

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Abstract

During 1 April - 3 December 1999, a total 8,825 cod (>45 cm fork length) were tagged with single, double, or high-reward t-bar anchor tags and released in Divs. 3KL at various inshore locations off the east and northeast coasts of insular Newfoundland, from Notre Dame Bay southward to St. Mary's Bay. A total of 791 (9.0%) were reported as recaptured during 1999 from recreational, sentinel, directed commercial and by-catch fisheries. Percentage of tagged cod released prior to the fishery and reported as recaptured varied among areas, ranging from 28.6% (n=1420) in 3Ki (Fogo-Twillingate area) to 4.8% (n=1046) in Trinity Bay. Substantial recoveries (≥7.2%) of cod tagged in various regions in southern 3L (Conception Bay southward) included many fall recaptures from neighboring Placentia Bay (Subdiv. 3Ps) where there was a directed cod fishery with landings during the last quarter of 1999 in excess of 7,500 t. The spatial and temporal distribution of recaptures is shown to be consistent with the results of other recent (1995-1998) tagging studies from these areas. The results further support my previous conclusion that the inshore of 3KL is inhabited by at least two groups of cod: (1) a northern resident coastal group that inhabits an area from western Trinity Bay northward through Bonavista Bay, the Fogo-Twillingate area, to western Notre Dame Bay, and (2) a migrant group from inshore and offshore areas of 3Ps that moves into southern 3L during late spring and summer and returns to 3Ps during fall. The timing of movement and northward extent of this migrant group may vary among years; however, during 1997 to 1999 few migrants appear have moved further north than Trinity Bay.

Résumé

Du 1er avril au 3 décembre 1999, un total de 8 825 morues (longueur à la fourche >45 cm) ont été marquées par étiquettes à ancre en T, à récompenses simples, doubles ou élevées avant d'être remises à l'eau dans les divisions 3KL en divers endroits des eaux côtières de l'est et du nord-est de l'île de Terre-Neuve, de la baie Notre-Dame jusqu'à la baie St. Mary, en direction sud. Au total, on a signalé 791 poissons (9,0 %) recapturés en 1999 par les pêches récréatives, sentinelles et dirigées ou sous forme de captures accidentelles. Le pourcentage de morues marquées remises à l'eau avant la pêche et signalées recapturées variait selon le lieu, allant de 28,6 % (n=1420) en 3Ki (région Fogo-Twillingate) à 4,8 % (n=1046) dans Trinity Bay. Une partie appréciable (≥7,2 %) des morues marquées récupérées dans diverses régions du sud de la 3L (Conception Bay et plus au sud) était constituée d'un grand nombre de recaptures faites dans la baie Placentia (sous-div. 3Ps) voisine où une pêche dirigée d'automne de la morue a donné lieu à des débarquements de plus de 7 500 t au cours du dernier trimestre de 1999. La répartition spatiale et temporelle des recaptures correspond aux résultats d'autres études de marquage récentes (1995-1998) réalisées dans ces régions. Les résultats confirment ma conclusion antérieure selon laquelle la partie côtière de 3KL est habitée par au moins deux groupes de morue : 1) un groupe côtier nordique résident d'une zone s'étendant, vers le nord, de l'ouest de Trinity Bay et englobant Bonavista Bay, la région Fogo-Twillingate et l'ouest de la baie Notre-Dame et 2) un groupe migrateur des secteurs côtier et hauturier de 3Ps atteignant le sud de 3L à la fin du printemps et à l'été et revenant en 3Ps à l'automne. Le moment des déplacements et la latitude nord atteinte par ce groupe migrateur peuvent varier d'une année à l'autre, mais de 1997 à 1999 peu de poissons semblent être allés plus au nord que Trinity Bay.

Introduction

During 1999 an extensive cod tagging program was initiated off the eastern and northeastern coasts of insular Newfoundland. Tagged cod were released in all major bays and coastal areas from Notre Dame Bay in NAFO Div. 3K southward to St. Mary's Bay in Div. 3L (Fig. 1). The tagging program was conducted in response to a recommendation by the Fisheries Resource Conservation Council (Anon, 1999) that an extensive tagging program be carried out off the northeast coast of Newfoundland to provide better scientific information on the status of the resource in these areas.

This document gives a synopsis of the spatial and temporal distribution of recaptures of tagged cod released in the inshore of 3KL during 1999 and reported as recaptured during 1999. Reported landings of cod during 1999 by month and statistical area are also summarized to aid in the interpretation of the recapture data. The distributions of recaptures from releases in 1999 are also compared to those from other recent tagging experiments in NAFO Divs. 3KL and adjacent areas (Subdiv. 3Ps). Information on stock structure and seasonal movement patterns from recaptures received in 1997 and 1998 is reported in previous documents (Brattey and Cadigan 1997; Lawson et al. 1998; Brattey 1999; Brattey et al 1999). Earlier cod tagging studies in these area are summarized in Taggart et al. (1995). Quantitative analyses of the recapture data from the current experiments, including estimates of tag loss, reporting rates, exploitation rates and growth, are presented elsewhere (Cadigan and Brattey 1999a, b; 2000).

Materials and Methods

Between 3 April 1999 and 2 December 1999 a total of 8,825 cod were captured with various gears (mostly hand-lines equipped with feathered hooks), measured (nearest cm) tagged with one or two t-bar anchor tags inserted at the base of the first dorsal fin, and released. Only cod ≥45 cm (fork length) and in excellent condition were tagged and each batch of cod consisted of individuals tagged with either single, double or high–reward tags in approximate proportion 4:4:2. The tags were uniquely numbered and bore a return address as well as the value of the reward ($10 or $100). The tagging program was advertised extensively among those participating in the fishery. Details of the tagging experiments are summarized in Table 1.

Reported landings of cod from the inshore of Divs. 3K and 3L were extracted from the ZIFF (Zonal Interchange File Format) database; offshore landings were negligible and were excluded. Monthly catches from the sentinel fishery were collated from records provided by sentinel fishers. Estimated catches from recreational cod fisheries held during July, August, and September 1999 were provided by Conservation and Protection Branch; these estimates were only available by month and NAFO Division and totaled only 234 t for 3KL combined. It was assumed that the catches were split equally between July, August and September and the recreational catch was partitioned among statistical areas using the corresponding breakdown of commercial catches for those months. Total reported catches by month and unit area are summarized in Table 2.

Results

Reported catch in Divs. 3KL

The geographic and seasonal pattern of reported landings (Table 2) was similar to that observed in 1998 (see Brattey 1999), with highest landings from adjacent areas in northern 3L and southern 3K, particularly eastern Notre Dame Bay (3Kh, 1107 t), Fogo-Twillingate (3Ki, 2300 t), Bonavista Bay (3La, 1675 t) and Trinity Bay (3Lb, 1443 t). Landings declined rapidly further west and north with a total of only 229 t reported from western Notre Dame Bay and the White Bay-Northern Peninsula area (3Kd, 3Ka). Landings from areas in the southern portion of 3L were generally smaller (< 702 t) than those from northern 3L.

There was little or no reported catch between January and the end of May throughout 3KL and small landings totaling < 20 t during June were mostly from the sentinel fishery. The directed cod fishery opened in early July and in most areas 25-50% of the total from each area was taken in that month. The directed cod fishery was closed from August 1 until September 15th and the small landings during this period came from sentinel and recreational fisheries. Reported landings during the second period of the directed cod fishery were generally higher in September and declined through October and November and the fishery was closed on November 15th. Minor landings during the latter part of November and during December were from sentinel fishers.

Numbers of releases and recaptures

The number of releases and percent of tagged cod reported as recaptured is summarized by experiment in Table 3; data from a single experiment conducted in 1998 are also included here. Most tagged cod were released in May and June prior to the start of the commercial in early July. Large numbers of cod (>1000) were tagged in the Fogo-Twillingate area (3Ki), Bonavista Bay (3La), western Trinity Bay (3Lb, mainly Smith Sound and adjacent areas) and off the southern Avalon (3Lq). Cod did not appear to be widely distributed and abundant in most of the areas where tagging was conducted; extensive searching was often required and only small but locally dense aggregations were encountered. The only exceptions, where cod were reported to be more plentiful, were in the Smith Sound area, off the tip of the Bonavista Peninsula, and off St. Shotts (3Lq) where a substantial aggregation of cod was observed in September. In Conception Bay (3Lf) and the eastern Avalon (3Lj) only small numbers of cod were tagged in spite of several attempts to locate significant aggregations of cod. Obtaining cod for tagging proved increasingly difficult in all areas during mid-summer as water temperatures

increased to record highs (see Colbourne 2000) and catchability with hand-lines (feathered hooks) appeared to decreased, possibly due to fish being glutted with capelin.

A total of 791 (9.0%) of the 8,825 tagged cod were reported as recaptured, but there were notable differences among areas in the percent of tagged cod recaptured during the 1999 fishery. The most significant finding was the extremely high return of tagged cod from releases in 3Ki, where 28.6% of the total released during June and July (n=1420) were reported as recaptured. The total reported landings from all of 3K combined were 3643 t (see Table 2). The percent recaptured from individual tagging experiments was consistently high (17.2 to 40.6%) and a single tagging of 118 cod in 1998 also generated a substantial number of recoveries (Table 3).

In most areas, cod tagged after the end of September generated few or no recoveries, presumably because most of the quota had been taken by that time (see Table 2). The only exception was for September tagging in St. Mary's Bay (3Lq), where significant recaptures were obtained from the directed cod fishery in neighboring Subdivision 3Ps, particularly Placentia Bay, which remained open throughout the fall of 1999.

In Bonavista Bay (3La), the overall percent recaptured from releases in May and June was 8.1% (n=1838), substantially lower than from the adjacent area to the north (Table 3). Percentage recaptured from individual experiments in Bonavista Bay were broadly similar, ranging from 3.3 to 12.5%. Reported landings from Bonavista Bay totaled 1443 t. In Trinity Bay (3Lb), the overall percent recaptured from releases in April to June was 4.8% (n=1046), with the percent from individual experiments ranging from 1.8 to 6.7%; landings from this area totaled 1675 t.

Tagging in Conception Bay generated a fairly high percentage of recaptures (7.2%) even though most of the tagged cod were released in mid-July and late August after the fishery was well underway. The percent of tagged cod reported as recaptured tended to increase in areas further south (3Lj, 3Lq) and ranged from 10.1 to 28.6%; the higher returns were mainly due to migration of tagged fish into neighboring Placentia Bay during fall. There was a substantial directed cod fishery in this area during October-December with landings in excess of 7,500 t .

Spatial and temporal distribution of recaptures in 1999

The geographic distribution of recaptures of tagged cod, grouped by area of release, is summarized in Table 4. Although in many instances the majority of tagged cod (> 50%) were recaptured in the same general area where they were released, the results also indicate substantial movements of cod between adjacent regions within the inshore. Between 9.6 and 24.5% of cod tagged in the three most northerly areas were recaptured outside the area where they were tagged. The most anomalous area was 3Lq where the majority of recaptures (84.1%) came from neighboring Placentia Bay. In general, the recaptures suggest an increasing north to south cline in the proportion of tagged cod recaptured outside the area where they were tagged.

Recapture locations of tagged cod from experiments conducted in each area, beginning in the north and heading southward, are shown in Figs. 2-11. These plots include recaptures from two tagging experiments in 3Ps (Figs. 10 and 11) that also had significant recaptures in 3KL. Only recaptures where exact latitude and longitude was reported are illustrated; this accounted for approximately 95% of the total recaptures. Some caution should be used in the interpretation of these plots; the numbers of recaptures within each region can be influenced by several factors, including the number of cod tagged, the amount and timing of fishing activity, as well as the relative abundance of local and migrant cod within each region.

Cod tagged in the Fogo-Twillingate area during June and early July were recaptured in large numbers on the northward side of New World Island and Fogo Island (Fig. 2), with some dispersal westward to Notre Dame Bay and eastward as far northern Bonavista Bay. Late summer (August-September) recaptures showed a similar dispersion pattern, but with fewer recaptures to the west and more recaptures southward into Bonavista Bay. In late fall, the recaptures were less widely dispersed from the tagging sites and many of the tagged cod were recaptured on the southward side of New World Island and Fogo Island, on the opposite side from where they were tagged.

Cod tagged in northern Bonavista Bay and in the extreme southern portion of 3K during mid-June were recaptured locally or had migrated northward to the Fogo-Twillingate area by July (Fig. 3). Late summer recaptures were similarly dispersed from the tagging site, but included more recaptures southward into Bonavista Bay. There were too few recaptures from fisheries in late fall (October-December) to provide information about cod movements at that time.

Cod tagged in southern Bonavista Bay during May and June were recaptured locally or had migrated considerable distances northward to northern Bonavista Bay, Fogo-Twillingate, or Notre Dame Bay by July (Fig. 4). By late summer (August-September) there was little change in the distribution of recaptures but many more tagged cod were caught compared to July, particularly within Bonavista Bay itself. Recaptures during late fall were also well dispersed and included some recaptures further south, but only as far as Smith Sound in western Trinity Bay.

Release of tagged cod in western Trinity Bay during April-June generated few local recaptures, but many recoveries in southern Bonavista Bay during July (Fig. 5). This finding is consistent with previous tagging in this area (see Brattey 1999) and indicates a northward movement cod out of Smith Sound and adjacent areas during late spring and early summer. Recaptures during late summer (August-September) and fall (October-November) were dispersed on both sides of the Bonavista Peninsula, with more recoveries from the tagging area than during summer, suggesting that some tagged cod had moved back closer to the general area where they were tagged. There was no evidence of any southerly movement of tagged cod.

Although sample sizes were small, an August tagging in Conception Bay (Fig. 6), a June tagging off Ferryland (Fig. 7), and a September tagging off St. Shotts (Fig. 8), all gave similar findings. Recoveries were obtained either locally or in Placentia Bay during late fall, indicating in a clockwise migration of some of the tagged cod around the Avalon Peninsula toward 3Ps as fall progressed.

Cod tagged in St. Mary's Bay (3Lq) during early April (Fig. 9) had dispersed widely east and west of the tagging site by summer (mainly July) with recoveries in various regions of Placentia Bay as well as northward as far as eastern Trinity Bay. Fall recaptures were less dispersed than those in summer and came mainly from the southern Avalon. In late fall, particularly November, a substantial number of recoveries were obtained from the eastern and inner portions of Placentia Bay. The fishery in 3L was open until November 15th and landings during October-November were reduced (Table 2); however, the scarcity of 3L recaptures during November implies that many of the tagged fish had moved westward of the initial tagging site across the stock management boundary into 3Ps. In general, the results from this tagging experiment suggest that many of the fish tagged in St. Mary's Bay during early May originated from 3Ps and had already begun a seasonal anti-clockwise movement around the inshore of the Avalon Peninsula when the tagging was conducted in early May.

Cod tagged at the head of Placentia Bay during late April and early May 1999 dispersed widely throughout both sides of Placentia Bay by July, and some had migrated around the Avalon Peninsula as far north as eastern Trinity Bay (Fig. 10). During late summer and early fall (August-September) total landings in southern 3L (3Lf southward) were about 600 t (Table 2), but only a single Placentia Bay tagged cod was reported as recaptured in southern 3L. In contrast, considerable numbers were caught in 3Ps, suggesting that cod were moving back into Placentia Bay. In late fall, large numbers of tagged cod were caught on the eastern side and at the head of Placentia Bay, consistent with a return migration back toward the spring tagging site.

Cod tagged offshore in Halibut Channel in 3Ps during early April were recaptured in small numbers during summer and fall at several sites around the Avalon Peninsula in southern 3L, as well as in Placentia Bay; there was also a single recovery much further north from 3K (Fig. 11). Tagging in the same area during 1998 also resulted in a similar pattern of recoveries, indicating that offshore cod from southern 3Ps have contributed to inshore fisheries in the southern 3L during summer and fall in each of the past two years.

Spatial and temporal distribution of recaptures from tagging prior to 1999

Cod tagged during 1999 were at liberty for periods up to a maximum of only about 8 months and may not have had sufficient time to undergo extensive migrations. To investigate more long-term movements of tagged cod, the distributions of all recaptures (received to end of Feb 2000) with exact positions from tagging conducted in Divs. 3KL during 1996-1998 and from two areas in 3Ps during 1997-98 were also plotted, grouped

by area and time of release (Figs. 12-17). Details of these tagging experiments are described elsewhere (Brattey 1999; Cadigan and Brattey 1999).

Cod tagged in the Fogo-Twillingate area during 1996-1998 show a similar dispersal of recaptures to that of cod tagged in the same area during 1999 and recaptured in 1999 (see Fig. 2 and Fig.12). There is no indication of any further dispersal away from the tagging site in successive years after tagging; most tagged cod were recaptured locally, westward to Notre Dame Bay, or southward to Bonavista Bay.

Cod tagged in southern Bonavista Bay during the summer of 1996 and 1997 also show a similar distribution of recaptures to that of cod tagged in this area during 1999 and recaptured in 1999 (see Fig. 4 and Fig. 13). Most tagged cod were recaptured southward only as far as western Trinity Bay and northward to Fogo-Twillingate. There are a small number of recaptures further south in 3L and in Placentia Bay; however, these are to be expected as cod captured and tagged in Bonavista Bay during summer are likely to include a small proportion of migrant cod from 3Ps.

Recaptures from cod tagged in western Trinity Bay during spring 1999 are similar to those from tagging in this area during December 1995 and April-May 1997 (see Fig. 5 and Fig. 14) with a northward dispersal of tagged cod to Bonavista Bay and Fogo-Twillingate. The Trinity Bay tagging experiments that were conducted in the summer of 1996 (Fig. 15) show more recaptures southward into 3Ps than the spring tagging. This result is also consistent with the hypothesis that cod tagged in Trinity Bay during summer are likely to include some migrant cod from 3Ps.

For cod tagged in southern 3L (3Lj) during July-October 1996-1997, the distribution of recaptures was similar to that seen from the 1999 tagging (see Figs 6-9 and Fig. 16). Of 82 recaptures only three were observed north of western Trinity Bay, and most of the tagged cod were caught in southern 3L or 3Ps even up to three years later. The recaptures also include offshore migrants from 3Ps and are therefore consistent with the results in Fig. 11 which shows that some cod from Halibut Channel migrate inshore to the Avalon Peninsula during summer.

Recaptures from the 1999 spring tagging in Placentia Bay (Fig. 10) extended around the Avalon Peninsula into southern 3L; however, they did not extend as far northward as those tagged in Placentia Bay previous years and recovered in 1999 (Fig. 17). During 1999, the recaptures from these earlier experiments have extended further northward, along the western side of Trinity Bay; however; in all years the numbers of recoveries north of Trinity Bay were extremely small.

Conclusions

Recaptures of tagged cod from these experiments further support my previous conclusion that the inshore of 3KL is inhabited by at least two groups of cod: (1) a northern coastal group that occupies the area from approximately western Trinity Bay northward through

Bonavista Bay, the Fogo-Twillingate area and Notre Dame Bay; (2) a seasonal migrant group that includes both inshore (Placentia Bay) and offshore (Halibut Channel) cod from neighbouring 3Ps. There is much stronger evidence from the 1999 recaptures for a return of the migrant cod back to 3Ps during late fall, primarily because of the more substantial fall fisheries in both regions. However, the absence of a spring fishery (January-June) in 3KL makes it difficult to determine precisely when the northward seasonal migration begins; the migrant cod appear to be well dispersed northward into southern 3L when the commercial fishery opened in early July 1999.

Although some migrant cod may remain in 3L over winter and not return to 3Ps, the results from these tagging experiments give no evidence of a progressive northward movement of 3Ps cod into 3L over the 3-4 years that tagging has been conducted. The northern coastal population inhabiting the inshore of 3K and northern 3L appears to be a resident coastal population that is temporarily supplemented with migrants during summer. There may also be some remnants of the offshore northern cod contributing to this population in summer; however, currently offshore components remain at an extremely low level (Lilly et al. 1999) and how much they contribute to inshore populations during summer is not known.

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Table 1. Summary of details for cod tagging experiments conducted in NAFO Divs 3K.L during 1998-99 (BB=Bonavista Bay, CB=Conception Bay, TB=Trinity Bay, SMB=St. Mary's Bay, PB=Placentia Bay, FB=Fortune Bay, HB=Hermitage Bay).

DFO Stat. area	Year & expt no.	Area of release	Dates	Gear	Depth (m)	Number tagged	Mean length (cm)
3Ki	9807	South-east Fogo	18 June	trap	22	118	57.4
3Lq	9906	south of Colinet Island, SMB	8-10 May	otter tr'l/h'line	40-62	734	56.4
3Lb	9907	Smith Sound, TB	27 Apr.-4 May	handline	11-27	376	65.7
3La	9908	Plate Cove, BB	4-5 May	handline	20-40	309	62.3
3La	9909	Clode Snd. to Chance Hd., BB	11-12 May	handline	22-26	80	63.2
3Lb	9910	Smith Sound, TB	28 May	handline	10-30	224	70.0
3Ki	9911	Fogo	3 June	handline	9-18	122	61.2
3Ki	9912	Too Good Arm, Twillingate	9-11 June	handline	14-22	639	60.8
3Lb	9913	Northwest Arm, TB	7-8 June	handline	4-40	224	62.7
3Lb	9914	Trinity, TB	9 June	handline	15-48	222	62.7
3La	9915	Sandy Cove, BB	10-13 June	handline	15-24	164	64.8

Cont'd:

Table 1. Cont'd.

DFO Stat. area	Year & expt no.	Area of release	Dates	Gear	Depth (m)	Number tagged	Mean length (cm)
3La	9916	Swale Island, BB	10, 13 June	handline	20-30	372	61.2
3La	9917	Broom Close Head, BB	11-12 June	handline	20-31	305	63.7
3La	9918	Wesleyville, BB	10 June	handline	22	242	56.7
3La	9919	Silver Fox Island, BB	11 June	handline	27	157	61.7
3Ki	9920	Lumsden, Fogo	15 June	handline	29	10	62.3
3Ki	9921	Summerford, Twillingate	16 June	handline	27	3	56.3
3Kh	9922	Jackson's Cove, Green Bay	22 June	handline	22	3	67.3
3Lj	9923	Ferryland, eastern Avalon	28 June	handline	14	21	61.1
3La	9924	Bonavista, BB	24 June	handline	18	210	66.0
3Ki	9925	Too Good Arm, Twillingate	22-25 June	handline	24-27	571	61.5
3Ki	9926	Twillingate	6-7 July	handline	27	197	59.6

Cont'd:

Table 1. Cont'd.

DFO Stat. area	Year & expt no.	Area of release	Dates	Gear	Depth (m)	Number tagged	Mean length (cm)
3Lf	9927	Foxtrap, CB	19 July	handline	27	17	51.4
3Lf	9929	Kelly's Island, CB	25 Aug.	handline	30	177	55.4
3Lb	9930	Little Catalina	1-2 Sept.	handline	47-55	456	68.5
3Lq	9931	St. Shotts, Southern Avalon	2, 13 Sept.	handline	44	280	60.1
3La	9933	Wesleyville	21 Sept.	handline	27	107	55.9
3Ki	9934	Lumsden	22 Sept.	handline	26	101	51.9
3Lb	9935	Little Catalina	21 Sept.	handline	31	203	64.0
3Lb	9936	Smith Sound, TB	28 Sept.	handline	25	16	62.4
3Ki	9937	Ladle Cove	29 Sept.	handline	43	60	51.9
3Lb	9938	Smith Sound, TB	7-8 Oct.	handline	31	142	62.8
3Psc	9940	Bar Haven PB (Cage expt.)[1]	17 Nov.	otter trawl	50	79	63.9

Cont'd.

Table 1. Cont'd.

DFO Stat. area	Year & expt no.	Area of release	Dates	Gear	Depth (m)	Number tagged	Mean length (cm
3La	9941	Happy Adventure, BB	22 Nov.	handline	40	49	59.0
3Lb	9942	Smith Sound, TB	23-26 Nov.	handline	35	514	68.8
3Lb	9944	Smith Sound, TB	1-3 Dec.	handline	35	476	70.4

Table 2. Reported landings (t) of cod from the inshore of NAFO Divs. 3KL during 1999 including sentinel and recreational fishery catches.

MONTH	3KA	3KD	3KH	3KI	Total
1	0.000	0.000	0.00	0.17	0.17
2	0.000	0.000	0.00	0.00	0.00
3	0.000	0.000	0.00	0.00	0.00
4	0.000	0.000	0.00	0.00	0.00
5	0.061	0.000	0.12	1.61	1.80
6	0.060	0.585	3.44	15.09	19.17
7	6.721	82.030	655.39	971.47	1715.61
8	1.470	8.380	34.68	58.22	102.75
9	10.991	80.248	224.58	955.84	1271.65
10	4.440	26.336	129.74	233.88	394.39
11	0.000	8.184	59.48	69.49	137.16
12	0.000	0.000	0.02	0.51	0.53
Totals	23.743	205.763	1107.44	2306.27	3643.22

MONTH	3LA	3LB	3LF	3LJ	3LQ	Total
1	0.00	0.53	0.00	0.00	0.00	0.53
2	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	2.37	0.00	0.00	0.00	2.37
5	2.73	0.54	0.00	0.00	0.16	3.44
6	0.25	1.96	3.64	12.09	1.17	19.11
7	441.97	694.28	480.56	169.11	77.64	1863.56
8	29.19	15.43	9.73	18.99	12.60	85.95
9	810.87	568.96	119.99	340.99	95.22	1937.04
10	142.77	354.90	80.22	120.86	66.79	765.54
11	15.90	36.65	10.75	17.46	13.58	94.34
12	0.00	0.00	0.00	0.00	15.29	15.29
Totals	1443.70	1675.62	704.89	679.50	283.45	4787.16

Table 3. Summary of reported recaptures for cod tagged and released in the inshore of NAFO Divs. 3KL during 1998-1999.

Expt.	Area	Release date		Location	Number released	Recaptured		
		First	Last			1998	1999	Percent
9807	3KI	18JUN98	18JUN98	SOUTH EAST FOGO	118	14	9	19.5
9922	3KH	22JUN99	22JUN99	JACKSONS CV NDB	3	.	0	0.0
9911	3KI	03JUN99	03JUN99	FOGO II	122	.	21	17.2
9912	3KI	09JUN99	11JUN99	TOO GOOD ARM II	639	.	161	25.2
9920	3KI	15JUN99	15JUN99	LUMSDEN FOGO	10	.	3	30.0
9921	3KI	16JUN99	16JUN99	SUMMERFORD TW	3	.	1	33.3
9925	3KI	22JUN99	25JUN99	T GOOD ARM III	571	.	140	24.5
9926	3KI	06JUL99	07JUL99	TWILLINGATE III	197	.	80	40.6
9934	3KI	22SEP99	22SEP99	LUMSDEN II FOGO	101	.	0	0.0
9937	3KI	29SEP99	29SEP99	LADLE COVE	60	.	0	0.0
9908	3LA	04MAY99	05MAY99	PLATE COVE 2 BB	309	.	26	8.4
9909	3LA	11MAY99	12MAY99	S.BONAVISTA BAY	80	.	10	12.5
9918	3LA	09JUN99	10JUN99	GREENSPOND BBN	242	.	21	8.7
9915	3LA	10JUN99	13JUN99	SANDY COVE BB	164	.	13	7.9
9916	3LA	10JUN99	13JUN99	SWALE ISLAND BB	372	.	31	8.3
9919	3LA	11JUN99	11JUN99	SILVER FX I BBN	157	.	12	7.6
9917	3LA	11JUN99	12JUN99	BROOM CL HD BB	305	.	29	9.5
9924	3LA	24JUN99	24JUN99	BONAVISTA II BB	209	.	7	3.3
9933	3LA	21SEP99	21SEP99	WESLEYVLL 2 BBN	107	.	0	0.0
9941	3LA	22NOV99	22NOV99	HAPPY ADVENT BB	49	.	0	0.0
9907	3LB	27APR99	04MAY99	SMITH SD III TB	376	.	21	5.6
9910	3LB	28MAY99	28MAY99	SMITH SD IV TB	224	.	10	4.5
9913	3LB	07JUN99	08JUN99	NW ARM II TB	224	.	15	6.7
9914	3LB	09JUN99	09JUN99	TRINITY TB	222	.	4	1.8
9928	3LB	06AUG99	06AUG99	NEW HARBOUR TB	486	.	37	7.6
9930	3LB	01SEP99	02SEP99	L. CATALINA TB	456	.	16	3.5
9935	3LB	21SEP99	21SEP99	L.CATALINA 2 TB	203	.	5	2.5
9936	3LB	28SEP99	28SEP99	SMITH SND V TB	16	.	0	0.0
9938	3LB	07OCT99	08OCT99	SMITH SND V1 TB	142	.	0	0.0
9942	3LB	23NOV99	26NOV99	SMITH SD V11 TB	514	.	0	0.0
9944	3LB	01DEC99	03DEC99	SMITH S V11I TB	476	.	0	0.0
9927	3LF	19JUL99	19JUL99	FOXTRAP CB	17	.	2	11.8
9929	3LF	25AUG99	25AUG99	KELLYS ISLND CB	177	.	12	6.8
9923	3LJ	28JUN99	28JUN99	FERRYLAND 3 AV	21	.	6	28.6
9906	3LQ	07MAY99	10MAY99	SE ST.MARYS BAY	734	.	74	10.1
9931	3LQ	02SEP99	13SEP99	ST SHOTTS S_AV	280	.	32	11.4

Table 4. Geographic distribution of recaptures of cod tagged and released in various inshore areas of NAFO Divs. 3KL during 1999.

Area	Nos. released	% of total recaptured in 1999									
Released	(recaptured)	3KH Notre Dame	3KI Fogo	3LA Bonavista	3LB Trinity	3LF Conception	3LJ E.Avalon	3LQ S.Avalon	3PSC Placentia	3PSB Fortune	3PSD Burgeo
3KI	1703 (419)	5.1	90.4	4.0	0	0.5	0	0	0	0	0
3LA	1994 (147)	0.7	18.4	75.5	5.4	0	0	0	0	0	0
3LB	3339 (102)	0	2.0	14.7	83.3	0	0	0	0	0	0
3LF	194 (14)	0	0	0	0	78.6	7.1	0	14.3	0	0
3LJ	21 (6)	0	0	0	0	0	50.0	0	50.0	0	0
3LQ	1014 (107)	0	0	1.0	2.8	0	3.7	4.7	84.1	2.8	1.0

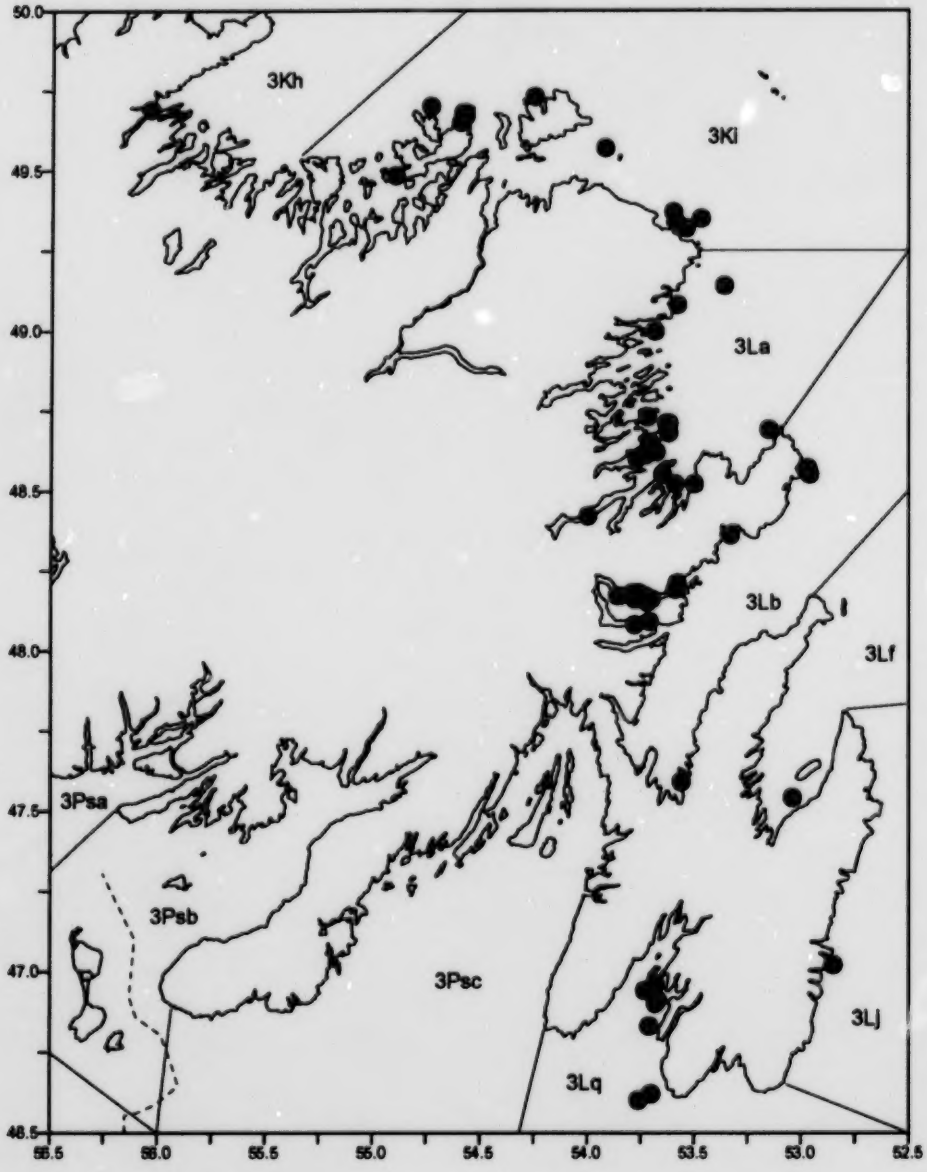

Fig. 1. Inshore locations where cod were tagged and released in NAFO Divs. 3KL during 1999.

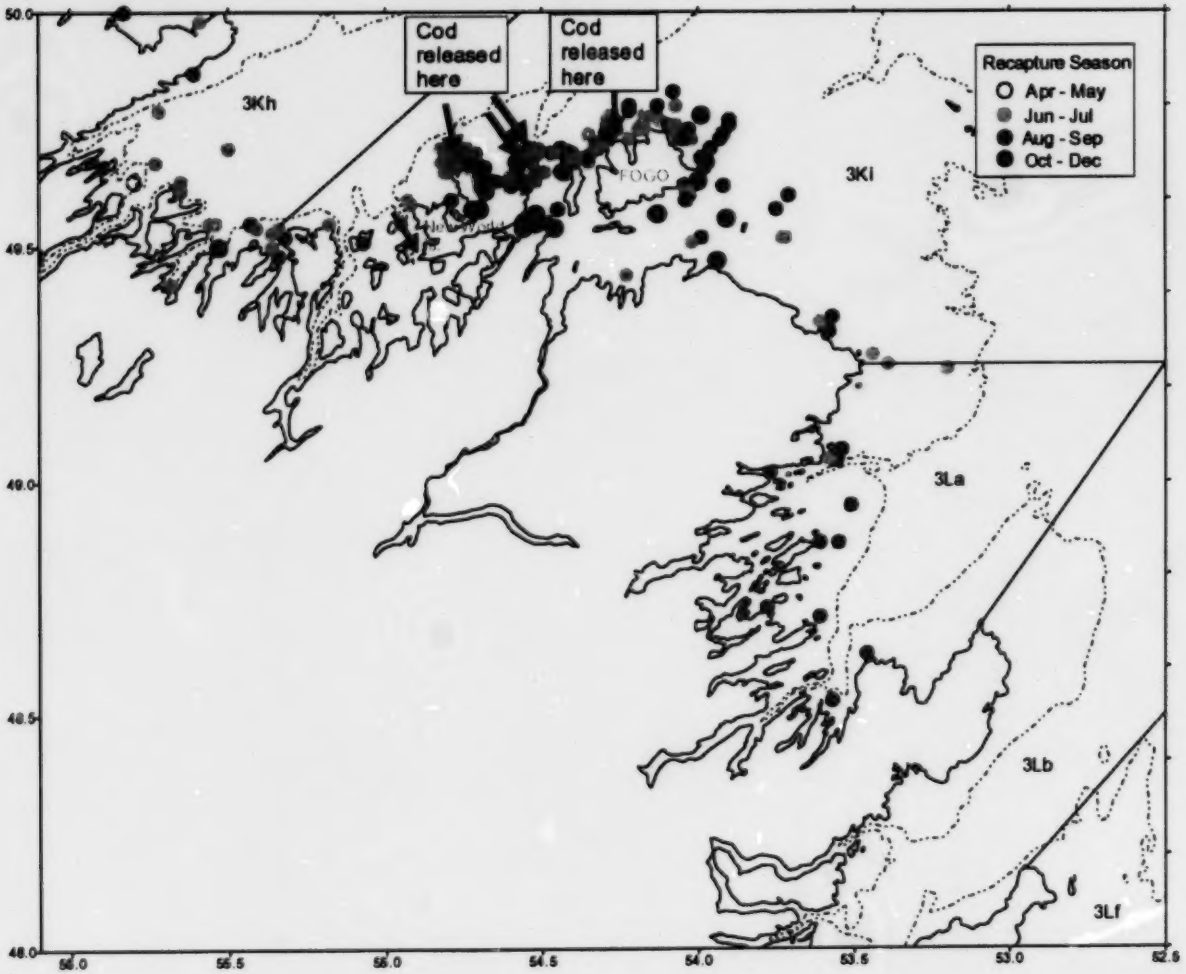

Fig. 2. Reported recapture positions by season for cod tagged and released off Twillingate and Fogo during 3 June-7 July 1999 (N=1542).

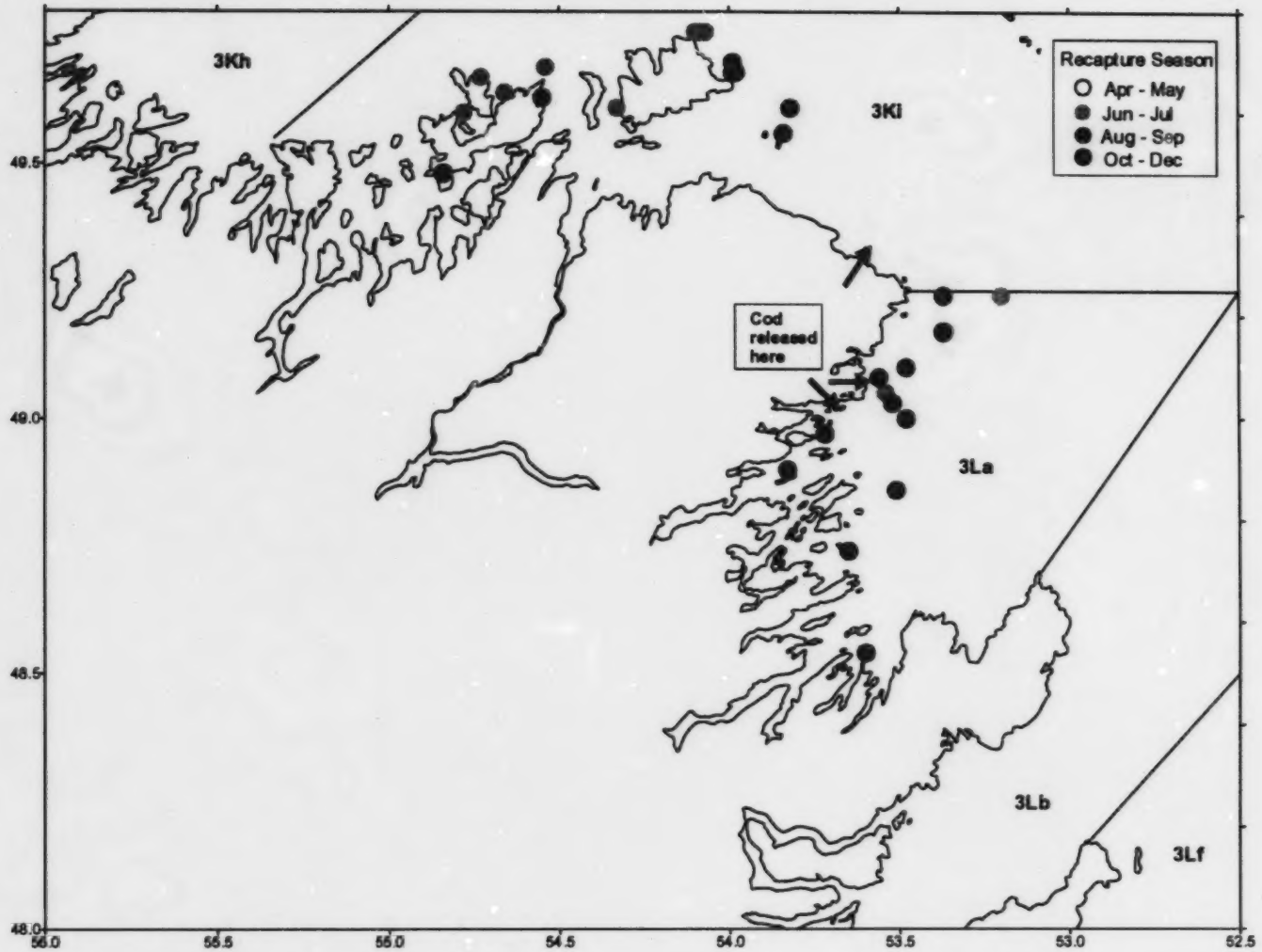

Fig. 3 . Reported recapture positions by season for cod tagged at Lumsden, Greenspond, and Silver Fox Island during 9-15 June 1999 (N=409).

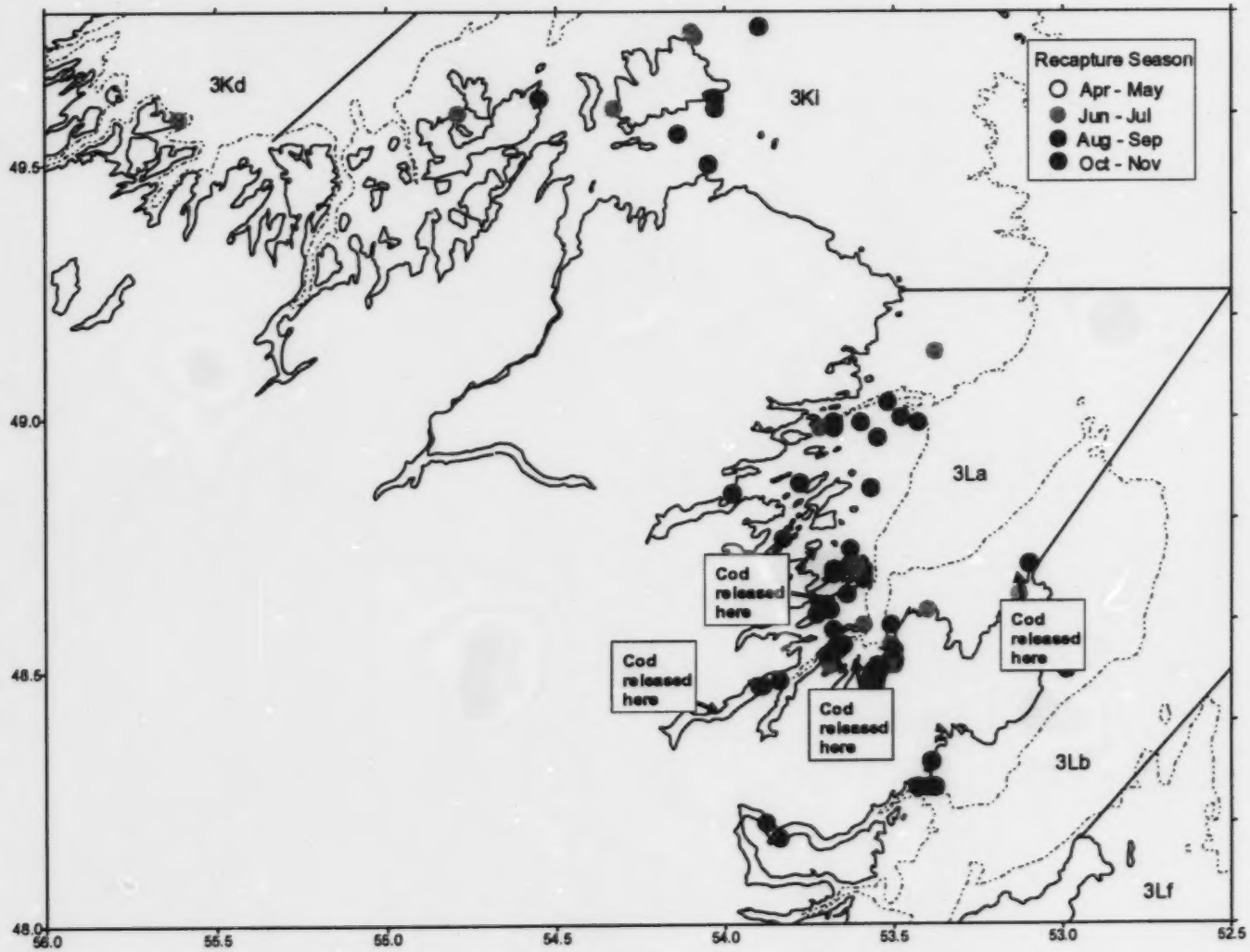

Fig. 4. Reported recapture positions by season for cod tagged and released in southern Bonavista Bay (Plate Cove, Clode Sound, Sandy Cove, Swale Island, Broom Close Head, and Bonavista during 4 May - 24 June 1999) (N=1440).

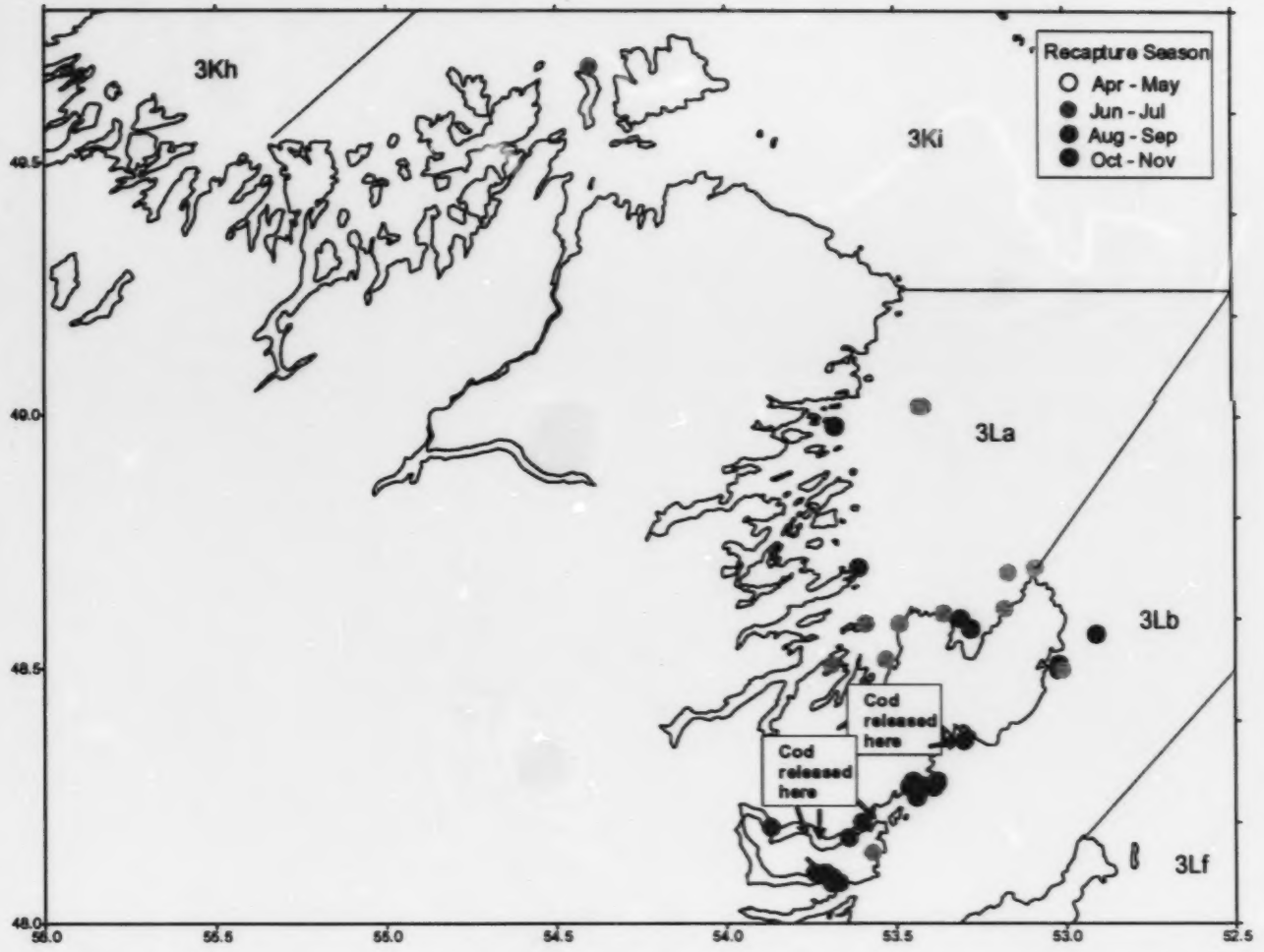

Fig. 5. Reported recapture positions by season for cod tagged in Smith Sound, NW Arm, Hickman's Harbour, and Trinity during 27 April - 9 June 1999 (N=1046).

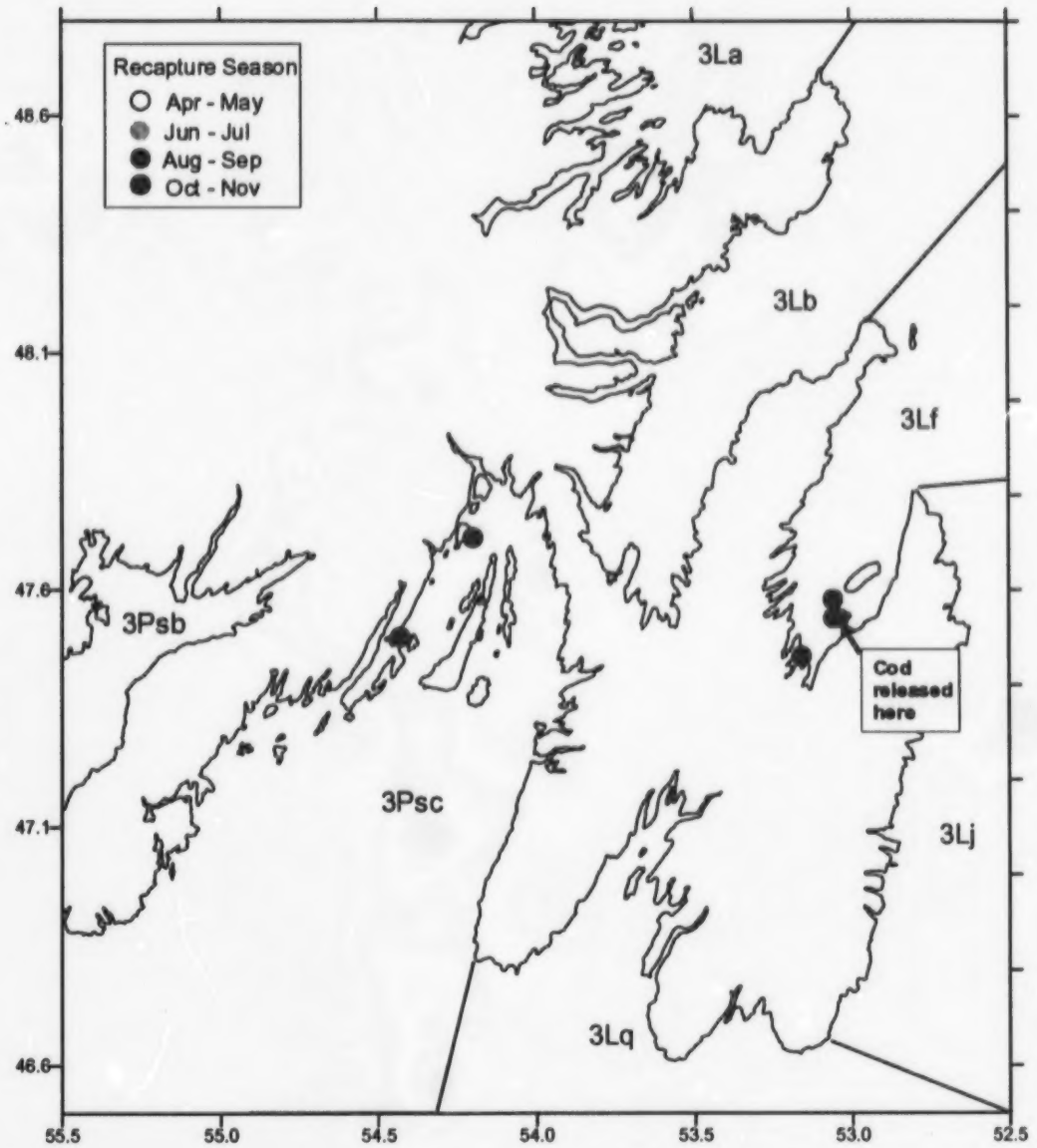

Fig. 6. Reported recapture positions by season for cod tagged off Kelly's Island, Conception Bay during 25 August 1999 (N=177).

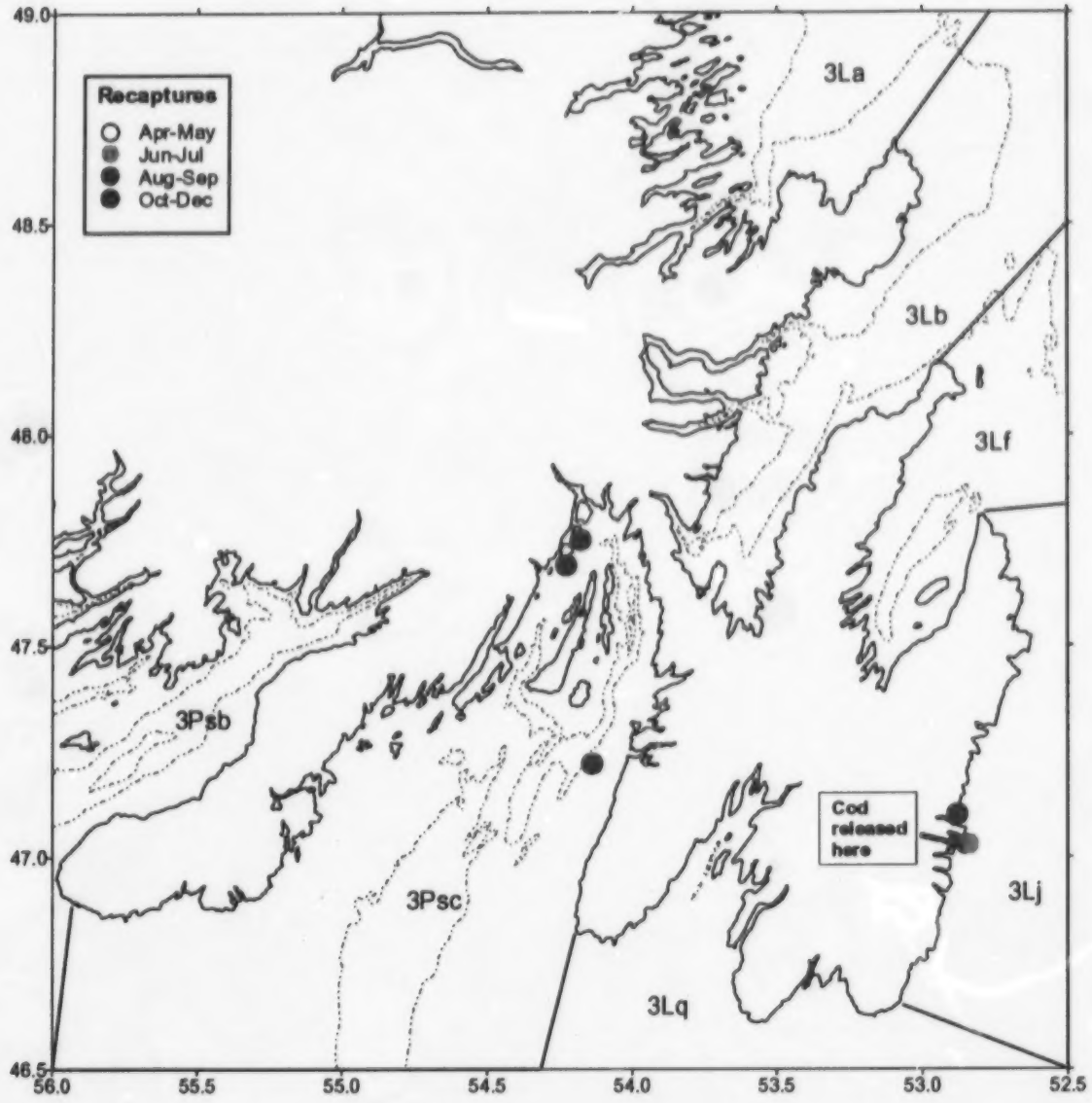

Fig. 7. Reported recapture positions for cod tagged and released off Ferryland (Exp 9923) during 28 June 1999 (N=21).

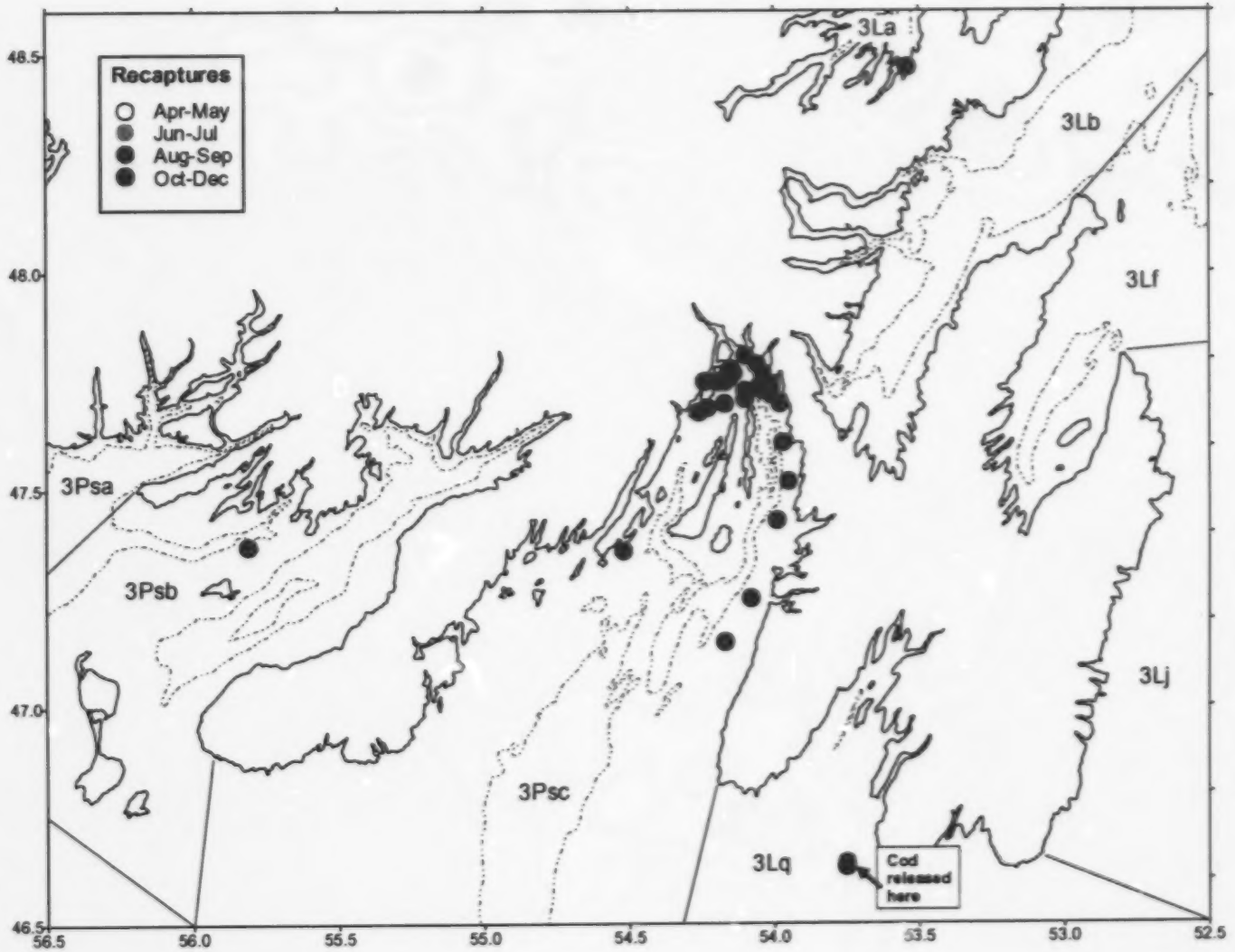

Fig. 8. Reported recapture positions by season for cod tagged and released off St. Shotts during 2 and 13 Sept 1999 (N=280).

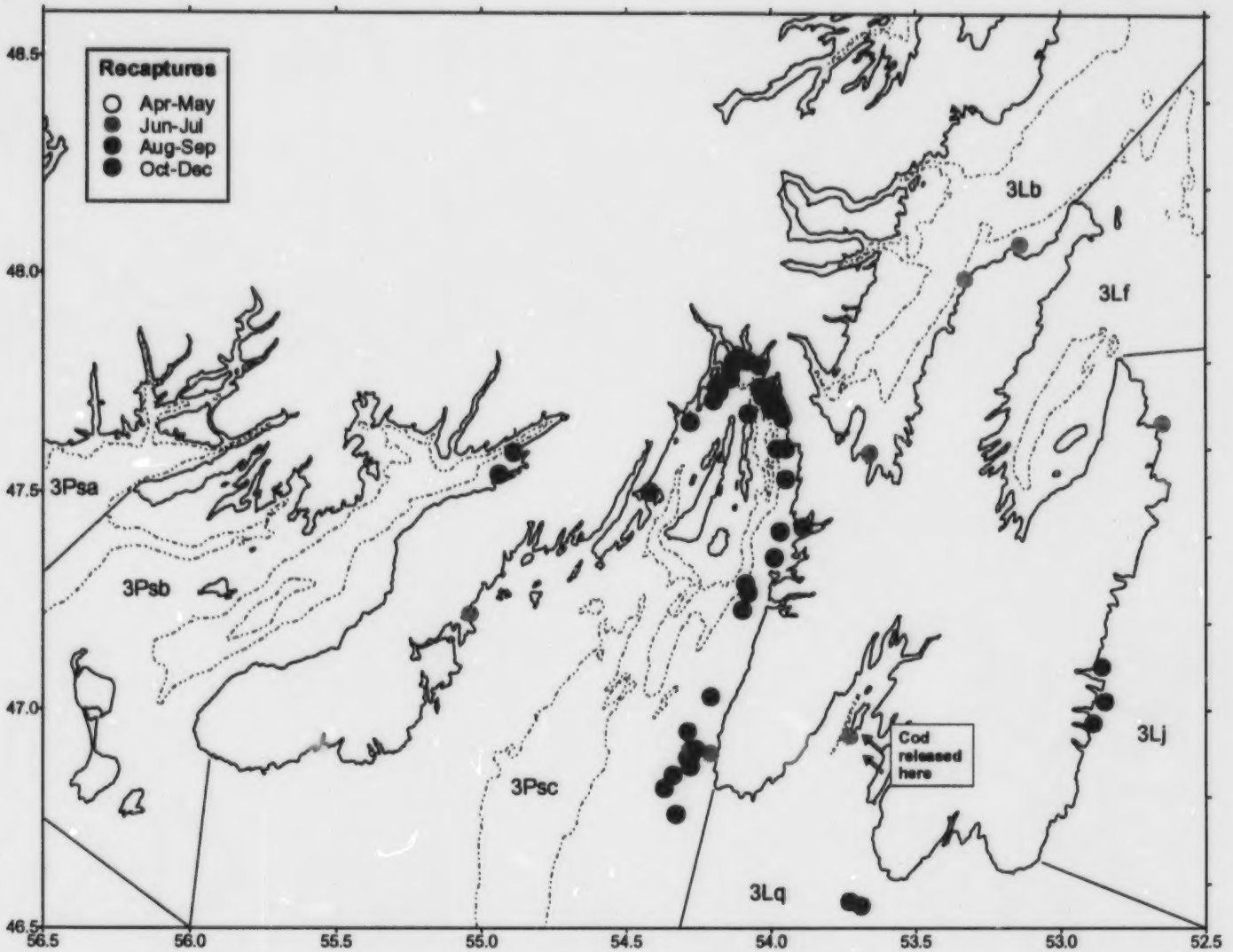

Fig. 9. Reported recapture positions by season for cod tagged and released in St. Mary's Bay during 8-10 May 1999 (N=734).

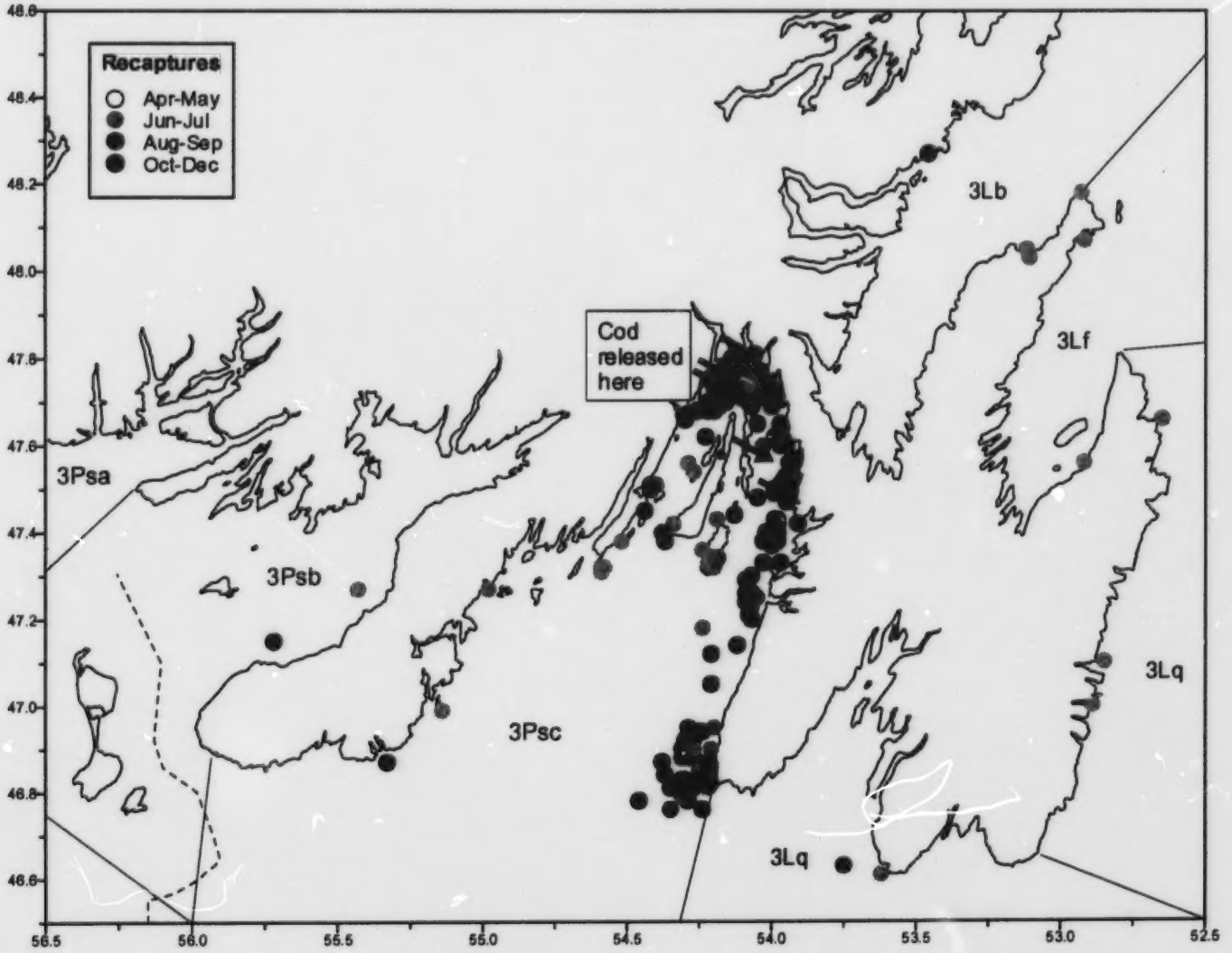

Fig. 10. Reported recapture positions by season for cod tagged at inner Placentia Bay during 29 Apr-7 May, 1999 (N=2422).

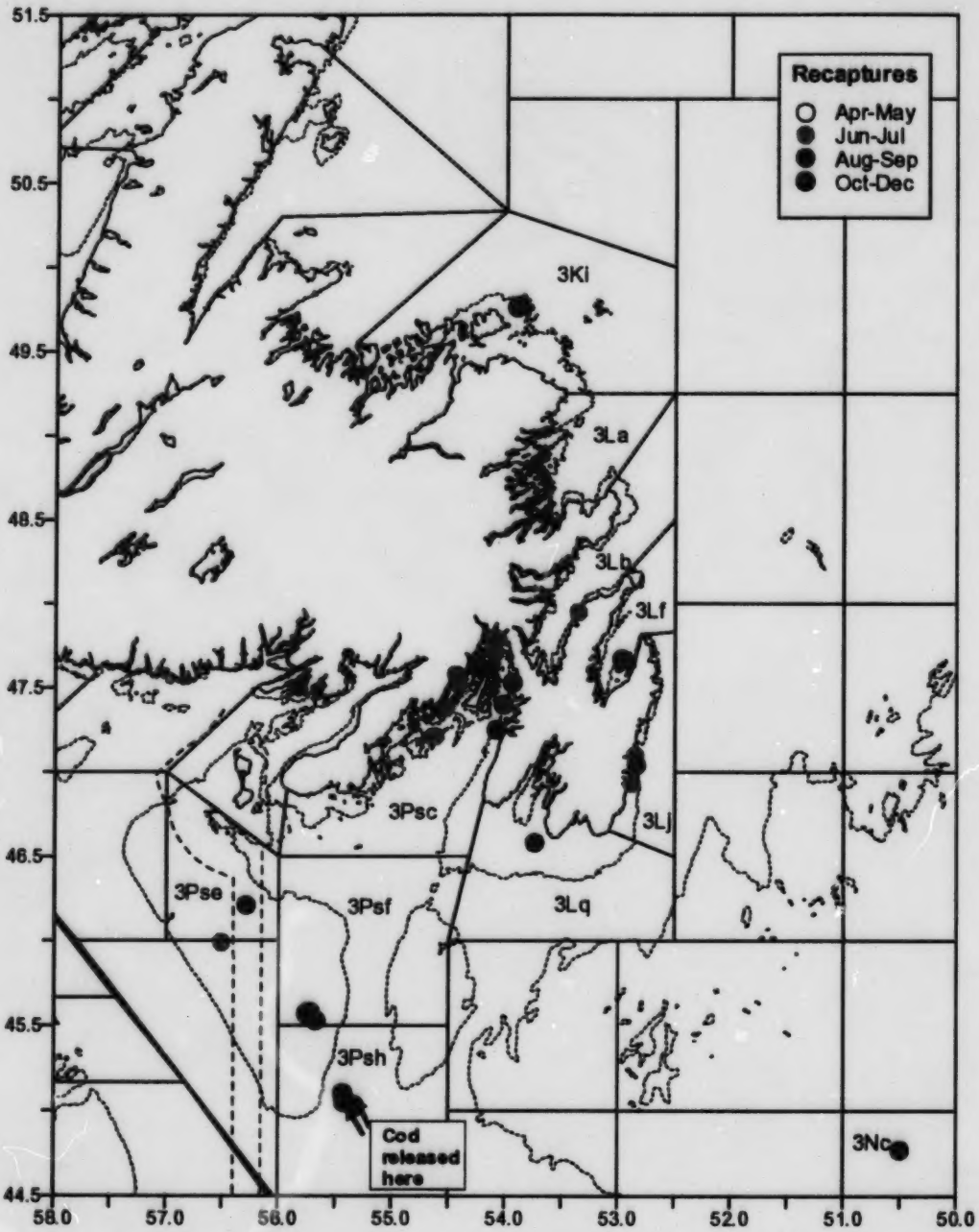

Fig. 11. Reported recapture positions by season for cod tagged and released in Halibut Channel (3Psh) during 1-3 April 1999 (N=1808).

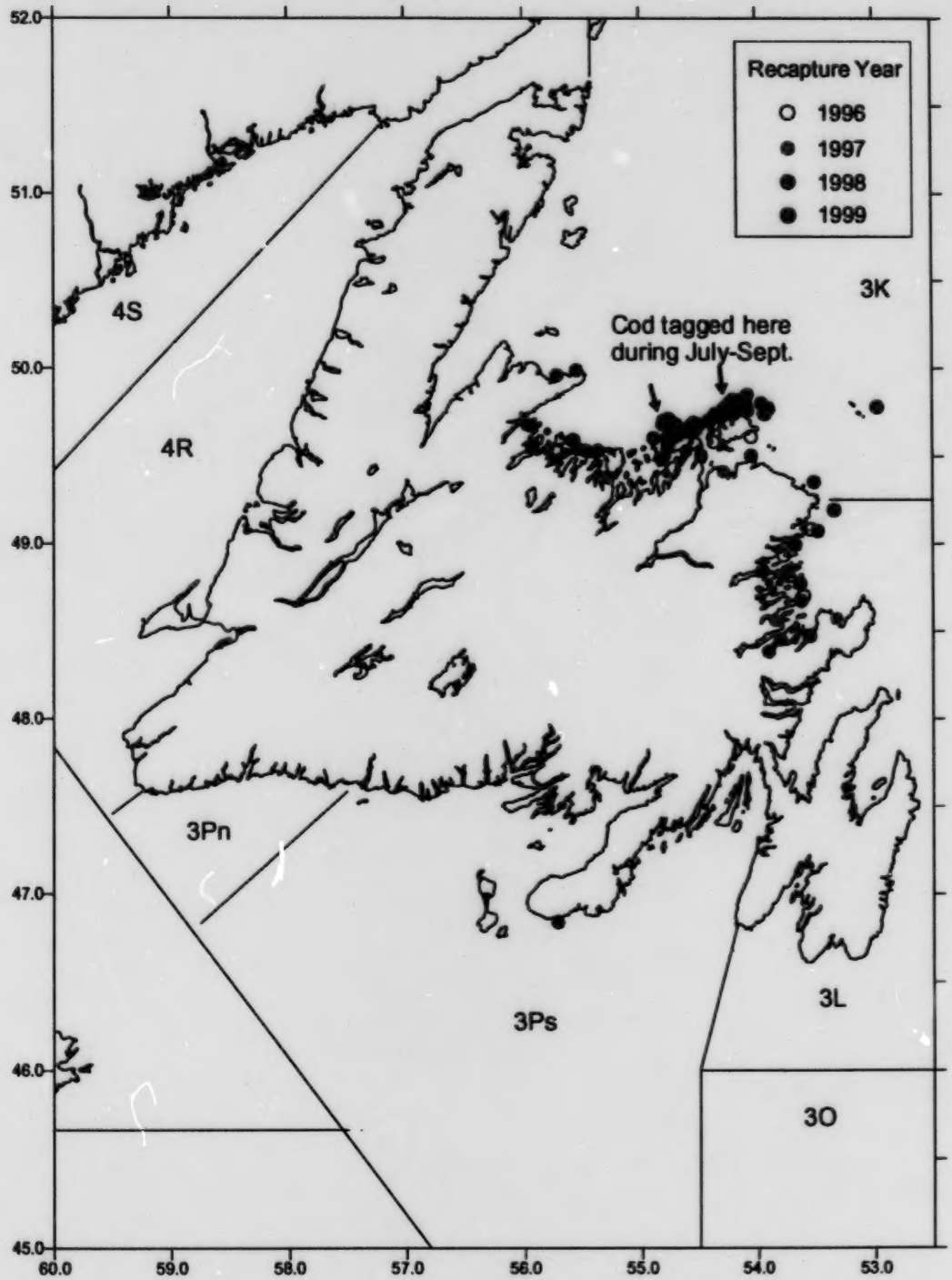

Fig. 12. Reported recapture positions for cod tagged in 3Ki during July-Sept.1996-1998 (approximately 85 recaptures have been reported to the end of Feb 2000).

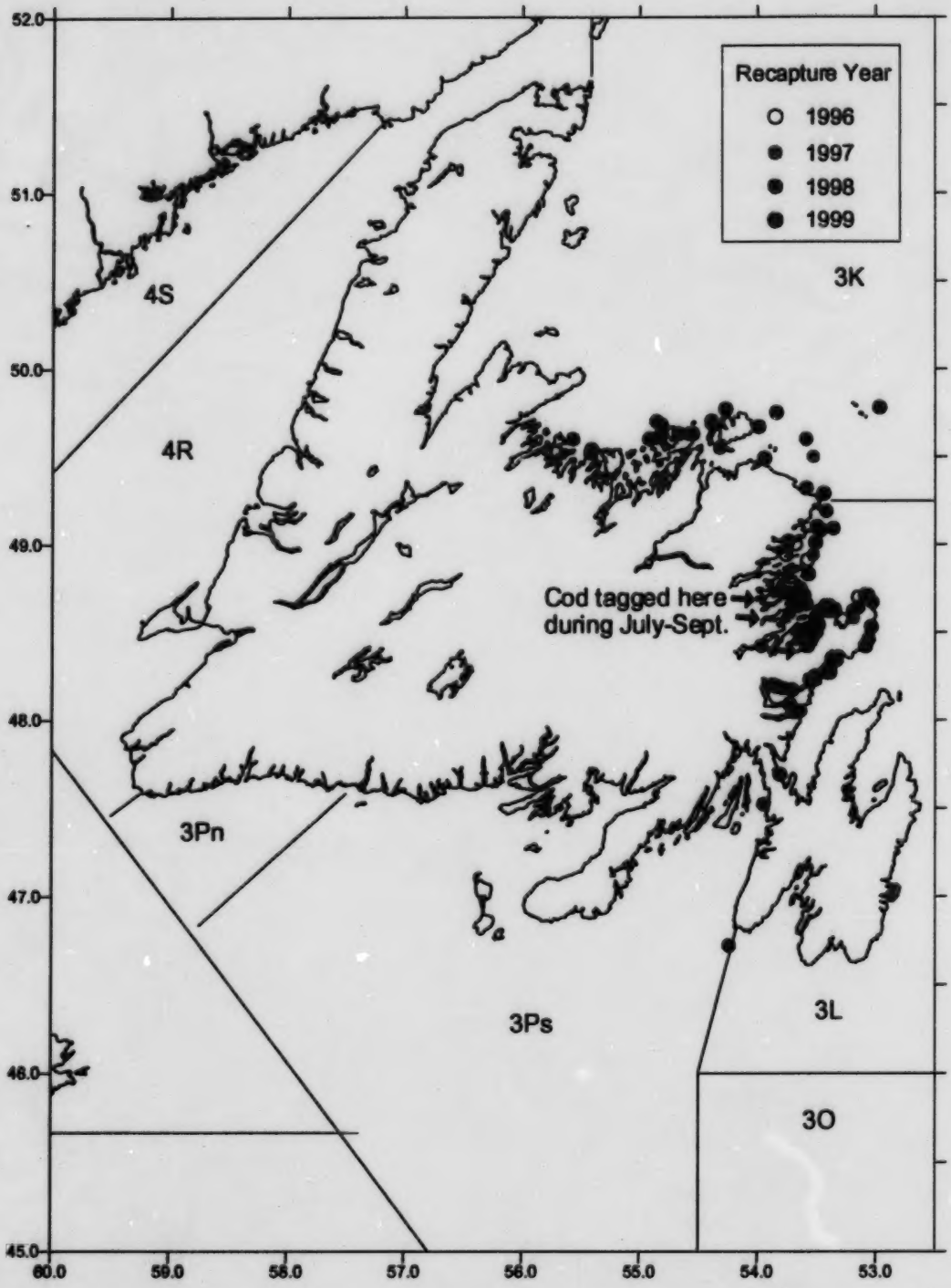

Fig. 13. Reported recapture positions for cod tagged in Bonavista Bay during July-Sept. 1996-1997 (approximately 124 recaptures have been reported to the end of Feb 2000).

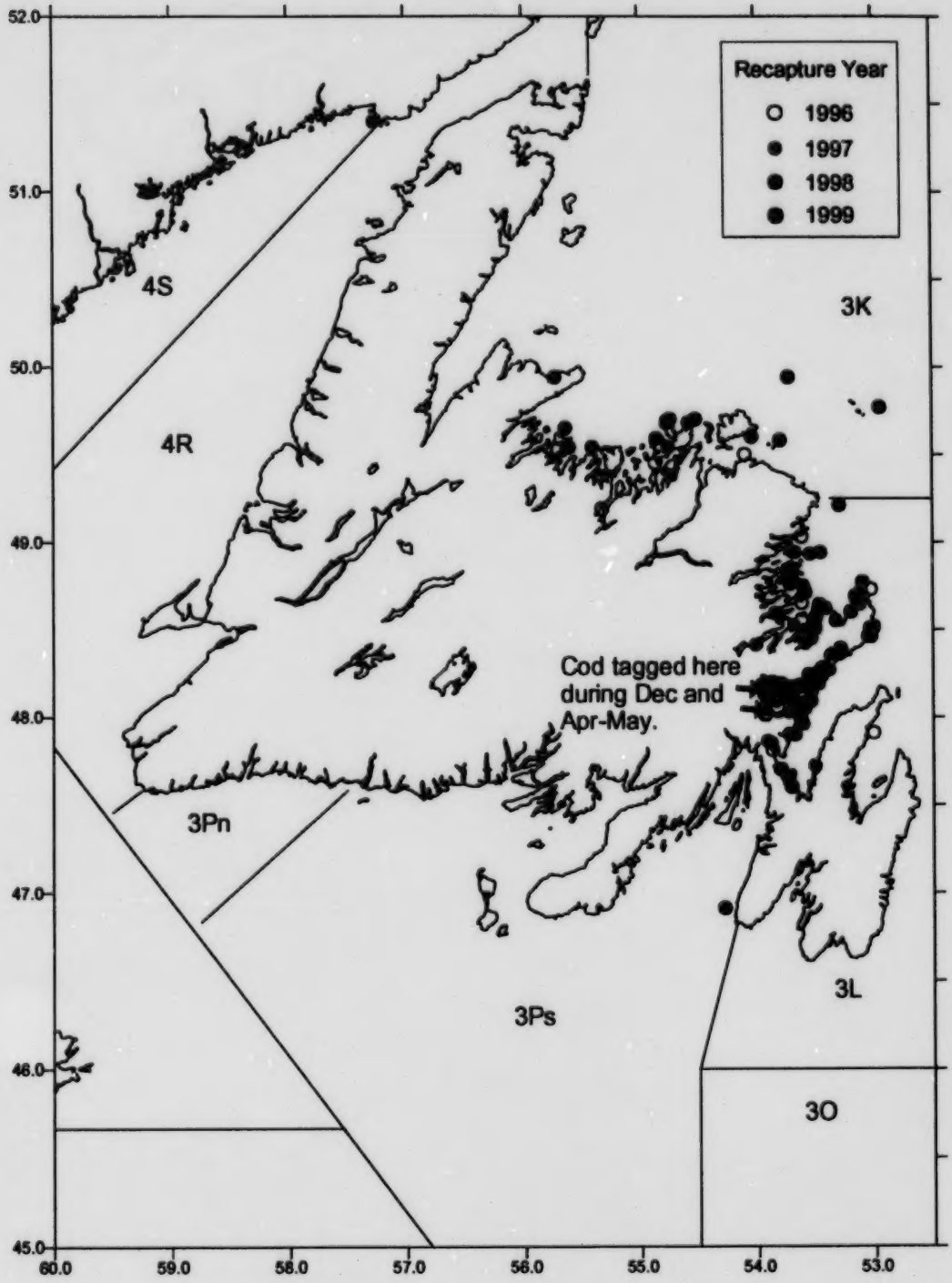

Fig. 14. Reported recapture positions for cod tagged in Trinity Bay during December 1995 and April-May 1997 (approximately 173 recaptures have been reported to the end of Feb 2000).

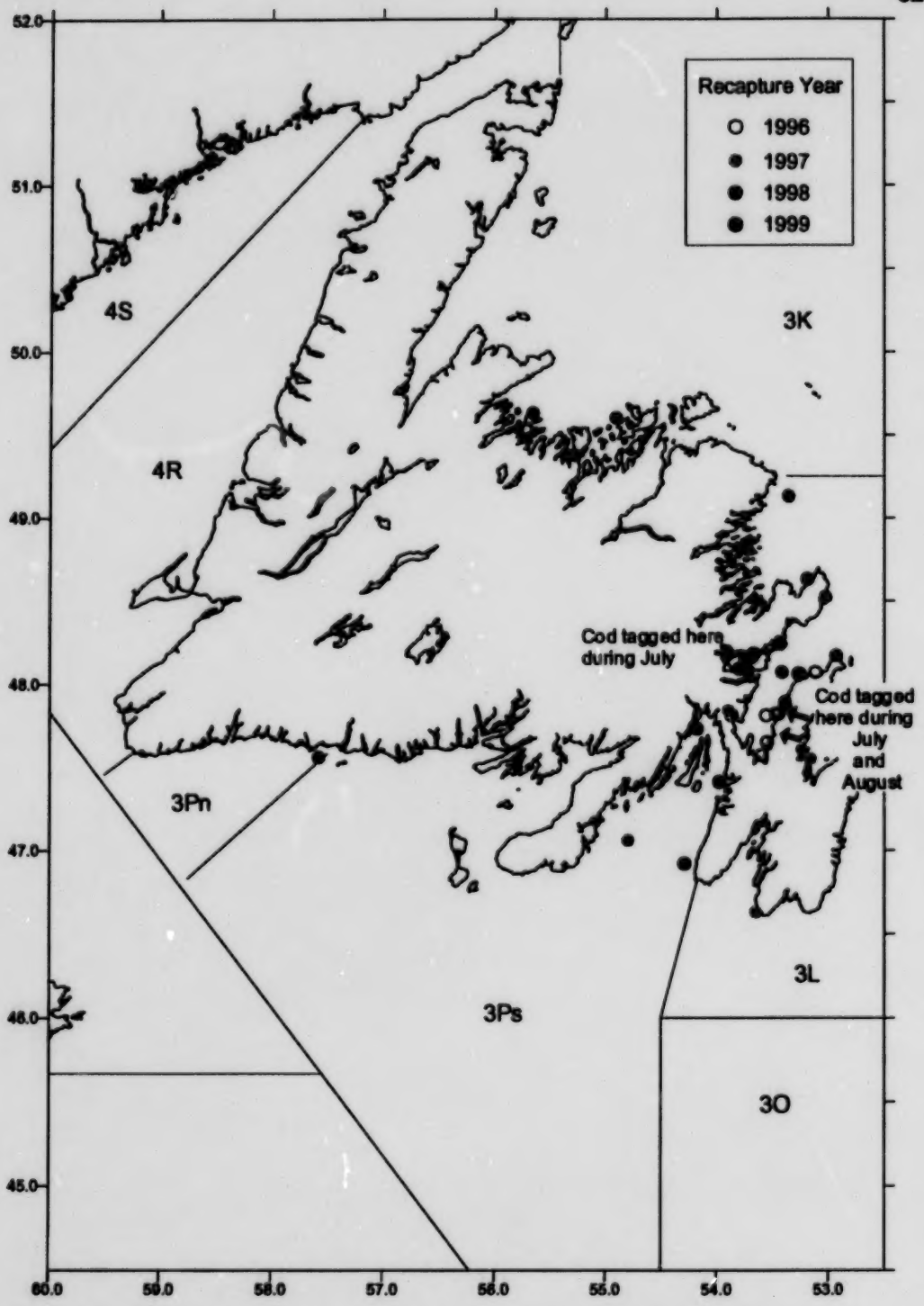

Fig. 15. Reported recapture positions for cod tagged in Trinity Bay during July and August 1996 (approximately 36 recaptures have been reported to the end of Feb 2000).

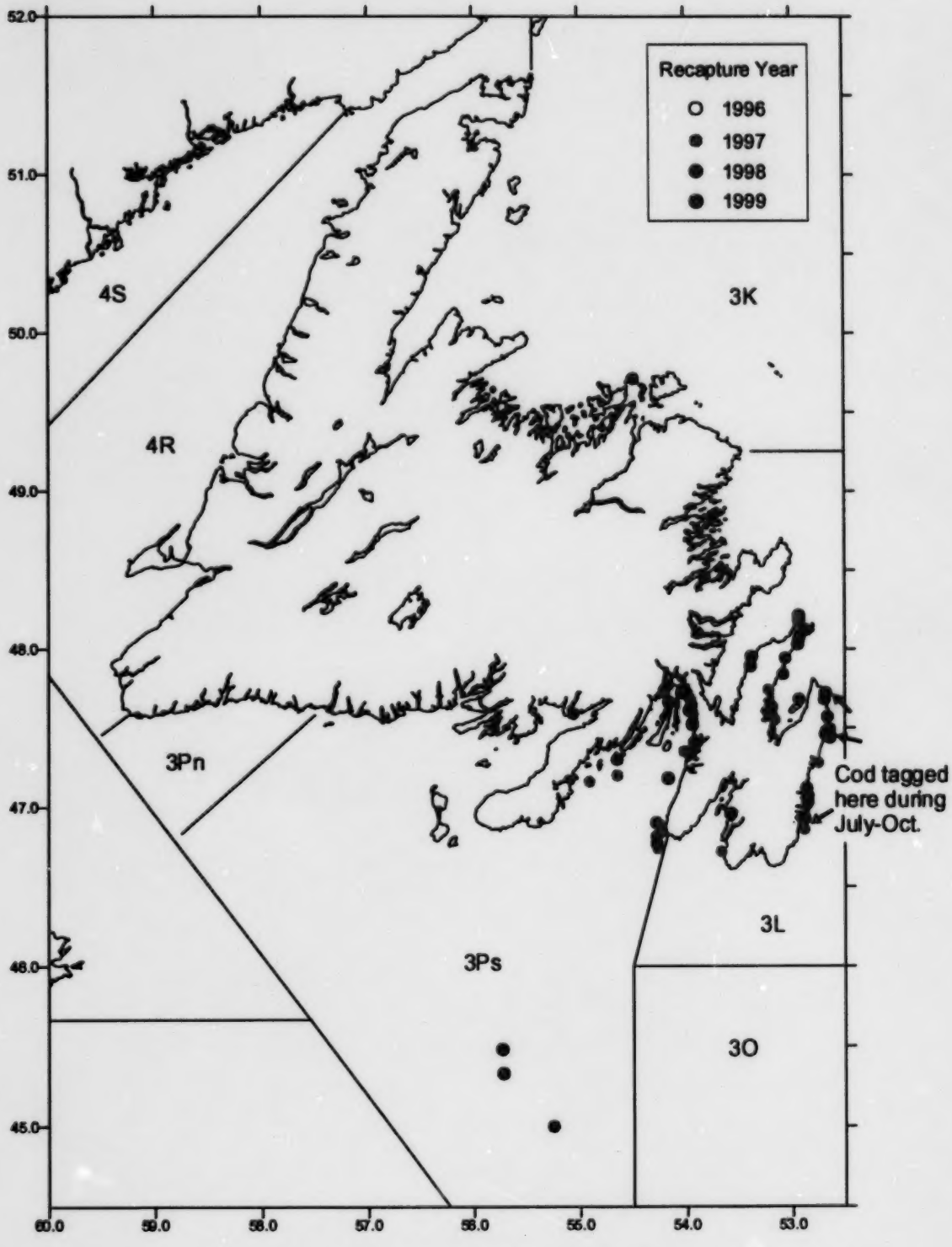

Fig. 16. Reported recapture positions for cod tagged off eastern Avalon during July-Oct 1996-1998 (approximately 82 recaptures have been reported to the end of Feb 2000).

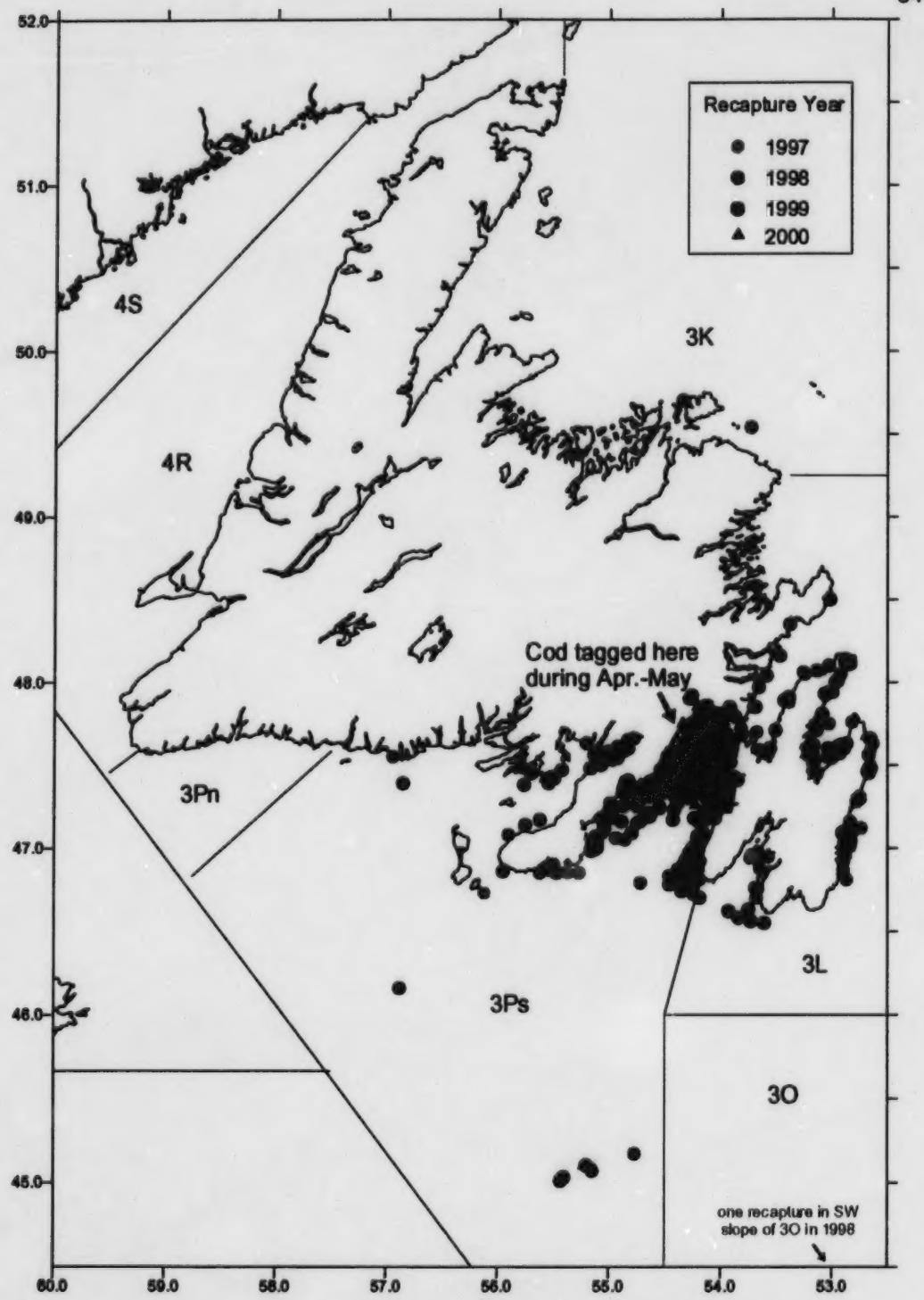

Fig. 17. Reported recapture positions for cod tagged at the head of Placentia Bay during April and May 1997-1998 (approximately 1390 recaptures have been reported to the end of Feb 2000).